ever known of animals so directly opposite in their dispositions forming an attachment of such singular nature. Their beautiful and interesting progeny are most admirable productions of nature. The group is truly pleasing and astonishing, and must be witnessed to form an adequate idea of them. The remarkable instances of subdued temper and association of animals to permit the keeper to enter their den, and to introduce their performance to the spectators, is the greatest phenomenon in natural history."

V. BALL.

OBSERVATIONS OF ATMOSPHERIC ELECTRICITY IN AMERICA.[1]

THE meteorological official of the United States known as "The Chief Signal Officer" has sanctioned the publication of this voluminous report of 320 quarto pages, embodying the result of a widespread photographic record and direct reading of atmospheric electrometers carried out under the auspices of the United States Government during the years 1884 to 1888, with the immediately utilitarian object of ascertaining how far it was possible to use electrical indication in weather prediction. As Mr. Mendenhall says, "No studies or investigations which did not bear upon this question were [considered] proper or allowable."

Although thus limited in scope the actual observations made and here recorded can hardly fail to be of service to future investigators into this obscure subject.

The report begins with a historical introduction, in which it is admitted that electricity was first purposely drawn from the clouds in France by Buffon and D'Alibard about a month before Franklin tried his already projected experiment; and that de Saussure was one of the first to obtain fairly quantitative results and to detect a diurnal period.

Volta "hit upon the capital device of a burning match" to replace the previous feeble collecting devices such as a bullet and wire shot up into the air. But nothing really exact and continuous was done "until Sir W. Thomson attacked the problem." He introduced the quadrant electrometer and the water-dropper, which have been the universal recording instruments ever since.

In fact "the work of Palmieri on Mount Vesuvius constitutes perhaps the only extensive series of observations in which instruments founded on the original design of Sir W. Thomson have not been used."

In the States the first energetic and influential mover in the direction of a serious record appears to have been Prof. Cleveland Abbé, who got himself authorised in 1880 by the Chief Signal officer to consult with Prof. Rowland on the subject, and afterwards with Prof. Trowbridge, and to make arrangements for a series of effective observations. Under the auspices of these gentlemen a staff of observers were trained and suitable instruments obtained, tested, and improved. Various collectors were tested, and in 1883 a photographic registration apparatus of M. Mascart was put into operation. In 1884 Mr. Mendenhall "was appointed to assume the direction of the work as chief of the physical laboratory and instrument division of the office in Washington." Stations were established in Washington, Baltimore, Boston, New Haven, Ithaca, and Ohio.

Much work was done in connection with electrometers by McAdie and McRae, but this is incorporated in the article "Electrometer" of the "Ency. Britt."

The instrument ultimately adopted was a quadrant electrometer of the Mascart pattern with special improvements, and was constructed by the Société Génevoise. A picture of it is given.

The method of connecting the quadrants to the two equal halves of a water battery, so that they might always be at equal opposite potentials, and of attaching the needle to the collector, was after many trials adopted; partly because higher insulation was thus possible, partly in order to get a straight line law. Deviation from this, due to what is called the "electric directing couple," is not overlooked, but by a stiff suspension and small range it is minimised.

An interesting chapter is that on "collectors." The water-dropper was mostly used, but its freezing is apt to interrupt the record. "Sergeant Morrill experimented on a special flame collector," supplied with gas at constant pressure and arranged so that wind could not extinguish it, and "before the termination of the work obtained very satisfactory results." But in order to secure uniformity between different stations he also designed a mechanical collector—a clockwork machine with revolving arm and intermittent contacts, which is virtually a gigantic replenisher, utilising the atmospheric potential as an inductor, and thereby feeding the electrometer up to the same potential. It seems to be as quick in response as a water-dropper (an important point, as some of the fluctuations of potential are very rapid), but "as it was only completed towards the end of the period of observation nothing very definite can be said of its performance." An illustration of the ingenious device is given in detail.

Observations.

Preliminary records are given showing the curves got at a roof station and a balcony station, also at different observatories in the same town. Some also from the top of the Washington Monument, which naturally show far greater potential and changes than the instrument in the Signal Office.

There are plotted a number of zigzags obtained from the different stations about the States, and very complicated and entangled the record is. None of the stations show any agreement; and, particularly at Ithaca, the electrometers seem usually to have been in a wildly excited state.

But during an Aurora on May 20, 1888, they were singularly quiet, and the remark is made: "It will be observed that the indications of the electrometer were positive during the day and night, and that no unusual fluctuations occurred."

The atmospheric potential is usually positive, and it has been often thought that a change to negative signalised bad weather. Certainly this does frequently happen; sufficiently often to make it worth while specially to examine this point; and several curve charts are given to show that "negative electricity in clear weather was observed at most if not all of the Signal Service Stations on numerous occasions during the progress of the work. In many cases precipitation occurred at points 10 to 100 miles distant, but in others clear weather prevailed over almost the entire country. A number of instances of negative potential during clear weather occurred at Ithaca, where careful attention was given to the matter of special observation by Mr. Schultze."

Effect of Dust, Haze, Fog.

"The effect of dust, haze, smoke, &c., in producing negative potential has been noticed by more than one observer. [Query whether the negative potential can have ever produced or permitted the haze.—O. J. L.] Several instances of the action of clouds of dust were noted by Sergeant Morrill at Boston. On March 7, 1888, in the afternoon the potential was observed to fall rapidly from −90 to −270 upon the rising of an especially heavy cloud of dust, and similar phenomena were observed on April 7." "A fall of potential could be certainly predicted when a dust cloud was seen rising. On other days when high winds and dust clouds prevailed negative potential was observed. A figure is given of an observation at Terre Haute, Ind., on a day when a fog formed after sunset, and the potential then rapidly fell from + 1000 to − 200 volts." "The same phenomenon was frequently observed during the autumn when the formation of a haze or fog just as the sun was setting was a common occurrence."

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[1] "Report of Studies of Atmospheric Electricity." By T. C. Mendenhall. Extract from Memoirs of the National Academy of Sciences, 1889. (Washington.)

The observer at Terre Haute (Sergeant McRae) wisely made special observations as to the possible effect of locomotives on a railway a quarter of a mile distant; but, so far as the recods show, the passage of a train, when not happening to coincide with a fog formation, did not seem to disturb the curves.

Clouds and Wind.

"The direct action of a cloud or group of clouds in producing a fall of potential was often observed." For instance the following at Boston:—"In the morning of January 3, 1888, the potential had been steadily positive. At 11.30 it was + 32 volts, from which it fell steadily at the approach toward the zenith of a small cumulus cloud, reaching − 21 volts As the cloud passed away the potential rose to + 6, again falling to − 31 as a large mass of cumulus clouds approached. Later the sky became overcast, and the potential became steadily negative.

"On June 7, at 5.30 p.m., the potential fell from + 43 to − 173, and then rose slowly to its former value. The rise and fall occupied fifteen minutes, and coincided with the appearance over the buildings to the west of a fleecy cirro-stratus cloud and its disappearance over the institute building in which the electrometer was located.

"Again, on June 9 the potential was positive all day up to 5 p.m. At that hour it fell from + 73 to − 113, then rising to + 52. The sky was nearly free from clouds, and the fluctuation coincided with the approach and departure of a cirro-stratus cloud, passing about 15° from the zenith. The inductive action of the cloud was plainly suggested in all of these cases."

High wind also usually causes a drop of potential.

Averages.

Some charts are then given of average monthly potentials, showing nearly always positive average values, highest in the winter, lowest in summer.

Some smoothed diurnal curves are also given, and "seem to indicate the existence of two principal maxima of potential in the day, and also in a general way that one of these occurs not many hours before noon and the other toward the latter part of the day."

Thunderstorms.

Special attention was paid to the observations before, during, and after the occurrence of thunderstorms, but the needle then dashes wildly to either side, and sparks often begin to pass. And the remark is made: "Aside from the general characteristics (rapidity and range of fluctuation) these potential curves seem to have little in common. The examination of a few cases only might lead to interesting conclusions, which would almost certainly be overthrown by the study of a greater number. Sometimes the potential falls rather steadily until the violent movements begin, but sometimes it rises just as long and steadily. In many cases the fluctuations start from a high positive, while in many others the reverse is the case. The storm is usually accompanied by precipitation; sometimes this begins before the needle starts on its series of swings from side to side, and sometimes these movements precede precipitation. The steady rise of potential for some hours immediately following a thunderstorm may mean that clear and fair weather is to be expected, but Fig. 71 is good evidence that it may also be interpreted to mean that another thunderstorm is just at hand."

"Although these records are somewhat unsatisfactory as far as throwing any light upon the nature of thunderstorms, it must not be forgotten that with a single exception [two stations at Washington] none of these storms have influenced more than one station. The complete investigation of a storm would demand a large number of observing stations relatively near to each other, by means of which a full history of the potential changes about and in all parts of the storm could be obtained.

"Such an examination might result in bringing order and system out of what seems at present little less than confusion."

Then follow many specimens of the actual photographic record at Baltimore on days when lightning occurred, and finally a mass of tables embodying abstracts of results at the different stations, and also some taken at Kew and Greenwich in England; though at both of these institutions the scale used appears to be arbitrary.

General Conclusions.

Among the conclusions the following may be noted: "Instruments similar in every respect, separated by a distance of a hundred meters may give very dissimilar indications." (Not merely, it is explained, as regards *absolute* values only, which may be expected to disagree, but as regards fluctuations also.) "Observers were instructed to study the appearance of negative electricity before and after and during precipitations, and at one time the hope was indulged in by the writer, as well as by several of the observers, that this phenomenon might afford great assistance in the prediction of local storms, rains, snows, &c., which offer so much difficulty in forecasting by present methods.

"Further observation and investigation, however, did not justify this expectation, serving rather to increase the meteorological conditions under which negative potential might be looked for, and to diminish the definition of relationship between it and precipitation. That negative electricity is tolerably certain to be observed in connection with precipitation in a majority of cases is doubtless true, but it does not appear in such a way as to be of any value in forecasting."

Near the end of the historical introduction we learn with regret that the observations thus tabulated and discussed are now no longer going on.

"In August, 1888, all observations were discontinued. It was thought that a sufficient number had been accumulated to decide the question of their use in weather forecasting, and in fact their study up to that date gave little encouragement in that direction." "Many questions of great scientific interest . . . had to be set aside for those likely to be of immediate practical value."

The amount of material thus rapidly accumulated, centralised, and well discussed, is typical of what can be done under efficient Government authorisation and by the head of a National Laboratory. The carrying on of the research for immediate utilitarian ends, and stopping it as soon as it was seen that the results aimed at were not forthcoming, is perhaps also typical.

It is to be hoped that some day the question will be reopened, and a fresh series of results obtained. So far as I (who am by no means a meteorologist) can judge, I should surmise that a number of fairly concentrated stations over a large plain would be desirable; and also that the vertical gradient of potential should be attempted by a series of collectors at different attitudes on a tall mast, or possibly up a hill-side.

Further, the general aspect of the curves seems to me to suggest that the instruments were almost too sensitive and not sufficiently dead-beat. They should be quick in indication and at the same time thoroughly damped, so that the record shall contain as little as possible of any effect due to instrumental inertia. Some very light quartz-fibre instrument might be devised, and perhaps it might contain its own recording apparatus in a compact form, so as to make registration a much easier and less cumbrous business than it has been hitherto.

When so much is unknown it is a mistake to begin by observing with too great intricacy of detail. The salient features should be first obtained, and then attention directed to the minutiæ; but one of the first things to do is to arrange that every swing in the curve shall mean a swing of atmospheric potential, and not a mere excursion of a heavy needle.

I hope that the energy, skill, and judgment of the various observers in the States, and of Mr. Mendenhall, the author of this valuable report, may be utilised through the resources of the U.S. Government by the inauguration of a fresh series of observations under somewhat different conditions, and without the hamper of any immediately specified practical object. OLIVER J. LODGE.

THE PRESERVATION OF THE NATIVE BIRDS OF NEW ZEALAND.

IN our issue of September 16 last year (vol. xlvi. p. 502) we printed an excellent memorandum drawn up by Lord Onslow, late Governor of New Zealand, relating to a proposal for the preservation of the native birds of that colony by setting apart two islands for this purpose, namely, Little Barrier or Hauturn Island in the north, and Resolution Island in the south. As regards the first of these islands, we have lately received a copy of the report by Mr. Henry Wright (addressed to the Hon. John Ballance, Premier of New Zealand) upon the subject. According to Mr. Wright, Hauturn Island, in the Gulf of Hauraki, which is almost circular in shape, and contains an area of from 9000 to 10,000 acres, rising in the middle to an elevation of about 2000 feet, is very well adapted for the purpose required. Writing with a thorough knowledge of all the north island, Mr. Wright is able to say that there is no other part of it where the native birds are to be found in anything like such profusion and variety. He gives a list of forty species to be met with within its limits, and mentions as particular varieties the stitch-bird or kotihe (*Pogonornis cincta*) and the large dark kiwi (*Apteryx bulleri*) as both found there. There are slight difficulties in the way of the project, such as the presence of about a dozen Maoris now living on the island, and of a claimant for the timber, which, in the shape of kauri pine (*Dammara australis*), is present in large quantities. There are no Weka Rails (*Ocydromus*) in the island to destroy the birds' eggs; and there are no bees, which, for some reasons, are considered to be highly inimical to the native birds in New Zealand. The wild pigs, formerly numerous, have been killed out; and the mutton-bird (*Œstrelata gouldi*), the young of which were formerly eaten by the pigs, will consequently be able to breed again undisturbed. Cats unfortunately are very numerous, but Mr. Wright proposes to offer at once a reward for their destruction, which is, of course, of great importance.

Mr. Wright's report seems quite convincing as to the suitability of Hauturn Island for the object in view, but we regret to hear that some difficulties have arisen in the Parliament of New Zealand as to the appropriation of the funds required for the purpose.

Lord Onslow, however, is not disposed to let the matter drop, and will, we are sure, be strongly supported by Lord Glasgow, the present Governor of New Zealand, in carrying the matter to a successful issue. The Council of the Zoological Society of London, whose attention has been called to the subject, have passed in its favour the following resolutions, which were communicated to a general meeting of that body on the 16th inst.

(1) The council of the Society have learnt with great satisfaction the steps that were proposed to be taken by the Earl of Onslow, when Governor of New Zealand, and by the Houses of General Assembly for the preservation of the native birds of New Zealand, by reserving certain small islands suitable for the purpose, and by affording the birds special protection on these islands.

(2) The council much regret to hear that difficulties have been encountered in carrying out this plan as regards one of these islands (Little Barrier Island), and trust that the Government of New Zealand may be induced to take the necessary steps to overcome these difficulties and to carry out this excellent scheme in its entirety.

(3) The council venture to suggest that besides the native birds to be protected in these reserves shelter should also be afforded to the remarkable Saurian, the Tuatera Lizard (*Sphenodon punctatus*), which is at present restricted to some small islands on the north coast of New Zealand, in the Bay of Plenty.

These resolutions have been communicated to the present Governor of New Zealand, and will, we trust, be of some assistance to him in inducing his Ministers to carry this excellent scheme into execution.

THE EARTHQUAKES IN ZANTE.

THE following is a list of the shocks of earthquake at Zante, compiled from telegrams published in the *Times* and *Standard*:—January 31, at daybreak, the most destructive earthquake, of which, however, some warning must have been given, if we may judge from the comparatively small loss of life. Other slighter shocks followed during the day. February 1, 2 a.m., another severe shock, felt also in Cephalonia. February 2, two more violent shocks, one of which caused some fresh damage. February 3, further shocks, but less frequent and violent. February 5, another violent shock. February 6, continued shocks of slight intensity, followed by three more severe ones in the afternoon and evening. February 7, another violent shock in the morning, resulting in but little additional damage. February 8, some slight shocks. February 10, some slight shocks in different districts. February 11, 1 a.m., a somewhat severe shock, followed by a succession of shocks between 8 and 9 p.m. February 12, further shocks in the early morning, soon after midnight, and again at intervals during the day. February 13 or 14, renewed slight shocks, accompanied by loud subterranean rumblings. The Athens correspondent of the *Times*, telegraphing on February 20, says: "The shocks of earthquake continue at Zante, with varying degrees of violence. No serious damage is reported, but those who are compelled to live in the half-ruined or insecure houses are exposed to frequent alarms." It is estimated that the total loss of property due to the shocks may exceed £600,000.

According to a telegram in the *Times* for February 6, the tide in Venice on the evening of February 1 "ebbed so low as to leave several of the canals without water. The gondola traffic was interrupted at different points, and many of those craft were stranded. This phenomenon corresponded with the earthquakes at Zante and Cephalonia." A simple calculation will show, however, that this can hardly have been due to the principal shock. The straight line joining Zante and Venice passes almost directly up the Adriatic, and its length is roughly 720 miles. Taking the time between daybreak on January 31 and the evening of Feb. 1 at 36 hours, this would give for the sea-wave an average velocity of 20 miles an hour, corresponding to an average depth of about 30 feet, which is considerably less than the actual amount, the mean depth of the Adriatic being 110 fathoms.

Earthquakes are frequent in Zante, and sometimes very severe. One of the most destructive shocks, which occurred on October 30, 1840, is described by Ansted in